16967

Army Support to Future Combat Systems Unmanned Ground Vehicles

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AUVSI Unmanned Systems Program Review

7 February 2007

SUPERIOR TECHNOLOGY

FOR A

SUPERIOR ARMY

TARDEC
U.S. ARMY TANK AUTOMOTIVE RESEARCH, DEVELOPMENT AND ENGINEERING CENTER

RDECOM

TACOM
The Soldier and Ground Systems Life Cycle Management Command

16967

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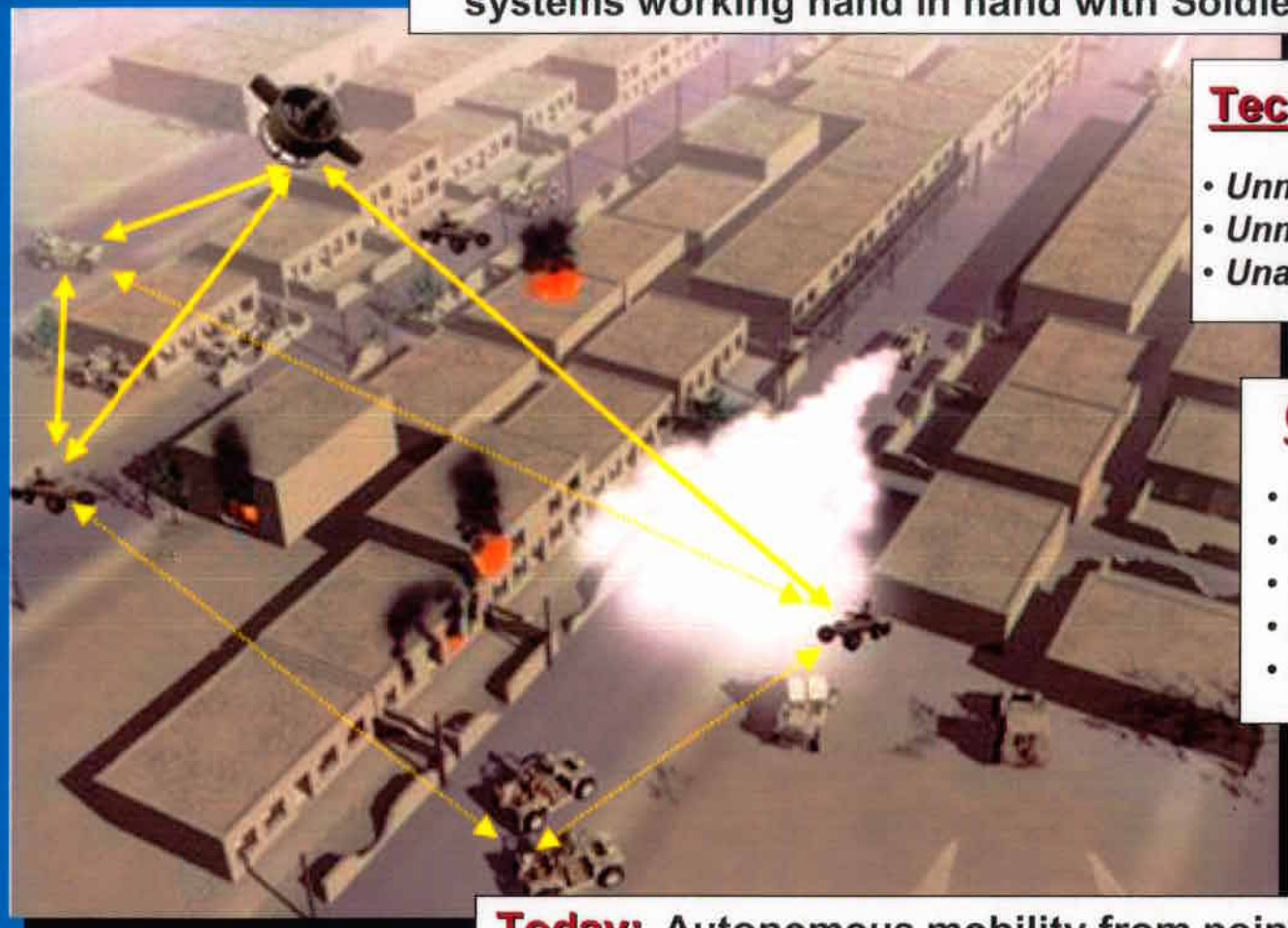
Army Support to FCS UGV's

- *Unmanned systems concept of operations in the future force*
- *Technology challenges to achieve FCS end state*
- *Priorities driving S&T investment*
- *Bridging the gap between current and desired performance capabilities*
- *Joint Center - Unmanned Ground Vehicles (JC-UGV) for development and transition of robotic ground vehicle technologies*

Future Unmanned Systems

The Future: Fully networked near-autonomous systems working hand in hand with Soldiers



Technologies Covering

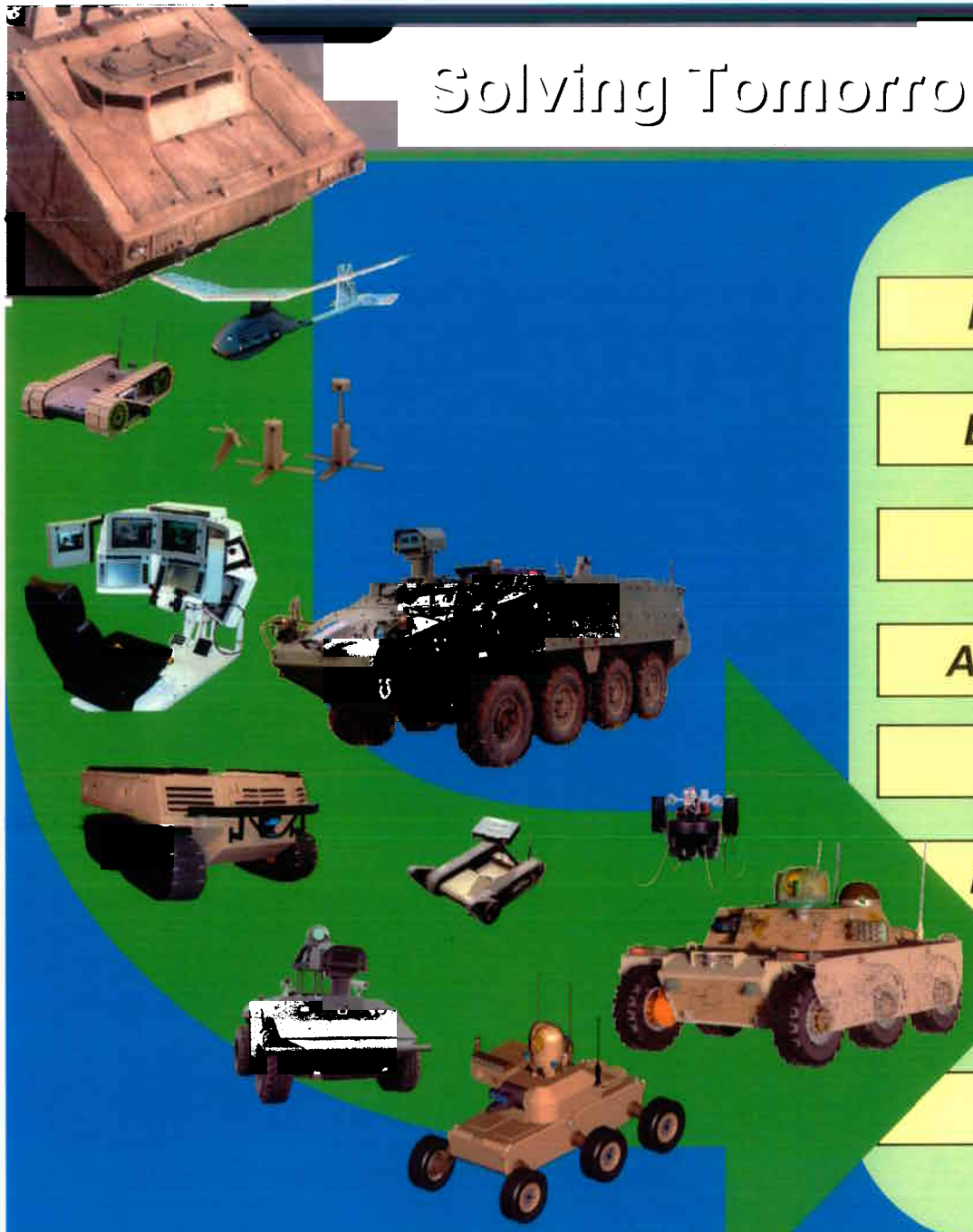
- *Unmanned Air Vehicles*
- *Unmanned Ground Vehicles*
- *Unattended Ground Sensors*

Core Technologies

- *Perception*
- *Intelligence*
- *Command & Control*
- *Platforms*
- *Safety*

Today: Autonomous mobility from point A to Point B in static environments

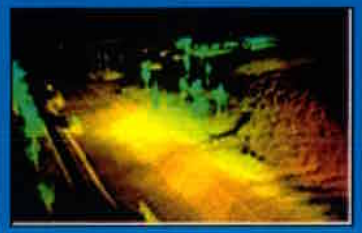
Solving Tomorrow's Challenges Today

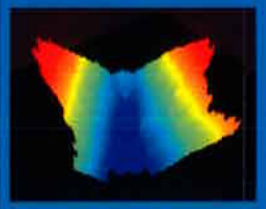


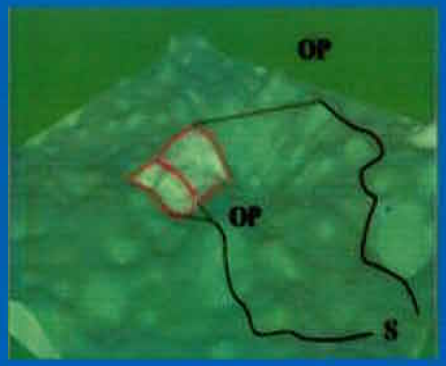
- Teleoperation
- Protection
- Safe Operations
- Bandwidth
- Power & Energy
- Planning
- Classification
- Affordability
- Latency
- Convoy
- Weaponization
- Behaviors
- Sensing
- OCU
- Mobility
- Resolution
- Interoperability
- Payloads

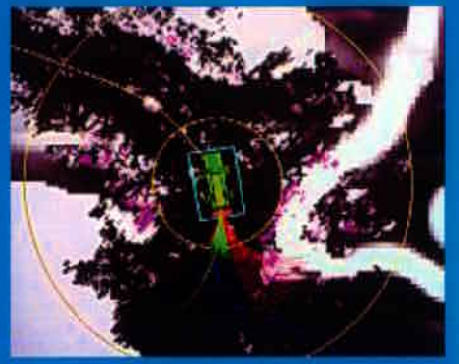
Army S&T Priorities for FCS Threshold Requirements

Intelligence/Tactical Behaviors









- Threat response/self security
- Tactical behaviors
- Formations/leader-follower

UGV Control for Overall System Effectiveness

- Warfighter machine interface
- Battle command integration
- Network constraints
- Weaponization

Safe Operations in Dynamic Environments

- Vehicle safety
- 360° Awareness

Platform Mobility Maturation

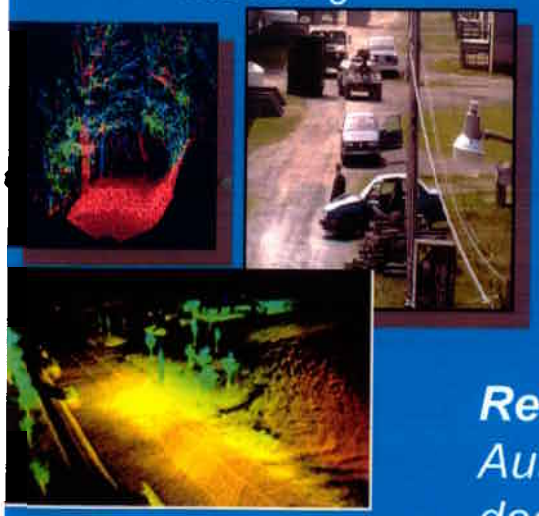
- SWaP Constraints
- Mobility enhancements
- Endurance

Intelligence/Tactical Behaviors

Current Performance

- *Point A to Point B autonomous navigation using a priori terrain info and local sensing for driving and situational awareness*
- *S&T progressing intelligent tactical behaviors in realistic scenarios*
  - *ARL Robotics Collaborative Technology Alliance*
  - *TARDEC/AMRDEC Robotic Collaboration ATO*
  - *TARDEC/ARL Near Autonomous Unmanned Systems ATO*

Perception and World Modeling



Deliberative and reactive planning

Layered detection and response

Required Performance

Autonomous, yet Soldier-like navigational decision making, threat detection and response, and collaborative behaviors to achieve a military objective

Formation control

Safe Operations in Dynamic Environments

Current Performance

- *Autonomous maneuver in complex terrain with stationary obstacles*
- *S&T progressing autonomous navigation in realistic scenarios*
  - *ARL Robotics Collaborative Technology Alliance*
  - *TARDEC Robotic Collaboration ATO*
  - *DARPA Urban Challenge*

Data collections with moving obstacles

Pedestrian Detection/Avoidance

Understanding dynamic environments for reactive planning

Required Performance

Autonomous maneuver in close proximity to pedestrians and vehicles to enable effective and safe Soldier robot teaming

UGV Control Integration (UCI)
Overall System Effectiveness

MGV Crewmen

TARDEC Stryker

DARPA Crusher 1.0

NMS Surrogate

NMS Surrogate

RSTA Surrogate

WMI Surrogate

BCME Surrogate

BCME Surrogate

VMS Surrogate

PPS Surrogate

ANS

Acronyms:
VTI = Vetronics Technology Integration
WMI = Warfighter Machine Interface
BCME = Battle Command Mission Execution
PPS = Planning and Prep service
NMS = Network Management Service
RSTA = Reconnaissance Surveillance, & Target Acquisition
VMS = Vehicle Management Software
ANS = Autonomous Navigation System

Existing SW Source Code (color key)

- VTI*
- Crusher
- ANS

Existing Operational Codes are Modified to enable FCS Representative Interfaces to be Monitored for Performance In UGV Functional Testing

Platform Mobility Maturation
Crusher 2.0 – Armed Robotic Vehicle

ARV SFR Guidance

FCS ANS Hardware/Software

Crusher 1.0 Baseline Design

UCI Hardware/Software

Key Tasks:
Complete Crusher2.0 Design
Fabricate Crusher 2.0
Integrate UCI HW/SW
Integrate ICS,Soscoe2.5,BC
System Shakeout

This concept leverages:
- **Army S&T mobility expertise/investment**
- **FCS/ARV SFR**
- **DARPA UPI lessons learned**
- **Industry expertise**

System Integration Team
Army S&T
FCS LSI
DARPA
Industry

Crusher 2.0

Weight = 9.31T including FCS payload allocations
98" max width, 97" max height,172" max length
Speed = 80kph at weight on road, 45kph x-country
400km range/70 gal diesel fuel
Acceleration (0-48kph, 0% grade, 49° C) – 10.5s

Joint Center for UGVs (JC-UGV)
Mission and Focus

Partner with universities to establish robotics curriculums and build expertise in military ground robotics to meet customer needs

University Outreach

Partnering with consortiums and national industrial base to develop and transition cutting-edge unmanned vehicle technologies to the Warfighter

Industry Partnering

Congressional Language

The budget request included $110.0 million in PE 63005A, for combat vehicle and automotive advanced technology. Under this account, the Army pursues survivability and mobility, communications, energy and power, and ***autonomous technology improvements for manned and unmanned ground systems***. The committee recommends an increase of $35.0 million in PE 63005A for acceleration of research in all of these areas, and $10.0 million for **unmanned ground vehicle prototype research to promote near-term transition of robotic ground vehicle technologies.**

Life Cycle Support

Partner with TACOM LCMC and RS JPO for total lifecycle decision and systems engineering support for the development and sustainment of robotics technologies

Government Research

TARDEC, the JC-UGV, RDECOM and OGA labs developing applied technologies to deliver the best possible solution to the Soldier

JC-UGV
R&D, Acquisition and Sustainment

Unmanned Systems Community

JC-UGV Collocation With the TACOM LCMC, RS JPO and TARDEC Fosters Technology Transfers Between Manned and Unmanned Systems

Manned Systems Community

Enabling Technologies

- Small UGV Prime Power
- UGV Armor and active protection
- Signature reduction
- Active suspensions
- Band track
- Power Mgmt
- Alternative power

Transfer

- Drivers' assistant
- Indirect vision driving
- Enhanced SA
- Auto NAV
- Tactical behaviors
- Reduced logistics
- Reduced human threat

Development

JC-UGV Coordination of TACOM/TARDEC Core Capabilities

Power and Energy — FY06 >$100M Manned
Fuel Cells
Pulse Power
Hybrid Electric
Intelligent Power Management
Batteries

Survivability
Signature Management
Active Protection
Lightweight Multi-Functional Armors
Landmine Protection
Laser Vision/sensor Protection

Mobility
Engines
Transmissions
Suspension
Tracks/Wheels
Vehicle Structures

Intelligent Systems — FY 06 >$20M Unmanned
Perception
Tele-operation
Autonomous Navigation & Intelligence
Human-Robot Interaction and Control
Actuator Kits

Partnering Opportunities to Deliver Technology to the Warfighter

University Outreach

- Establish robotics curriculums to build expertise in military robotics
- Fund long term and quick reaction technology development efforts focused on transitional solutions to material developers
- Foster individual efforts at local, state and national universities using various mechanisms

MICHIGAN · Robotics@GT Intelligent Machines · VirginiaTech Virginia Tech Autonomous Vehicle Team · Carnegie Mellon THE ROBOTICS INSTITUTE · Stanford AI Lab

Industry

- Maximize use of regional capabilities in automotive and defense based technologies.
- Exchange ideas and invest in technology development through existing CRADAs and contracts.

GM · Ford · DELPHI · EDS · Visteon · GENERAL DYNAMICS Strength On Your Side · DaimlerChrysler

Small Business

- Utilize SBIR and STTR programs to allow small high-tech U.S. Businesses and academia the opportunity to provide innovative R&D solutions to critical DoD needs.
- Propose new SBIR topics and Invest in existing SBIR enhancements/plus-ups to companies developing unmanned ground vehicle technologies

UNITED STATES ARMY SBIR STTR Programs

- **Intelligent Mobility**
- **Innovative Control**
- **Adaptive Payloads**
- **Advanced Sensors**
- **Intrinsic Mobility**

Forging relationships with leading national institutions